CEMENT AND LIME MANUFACTURE

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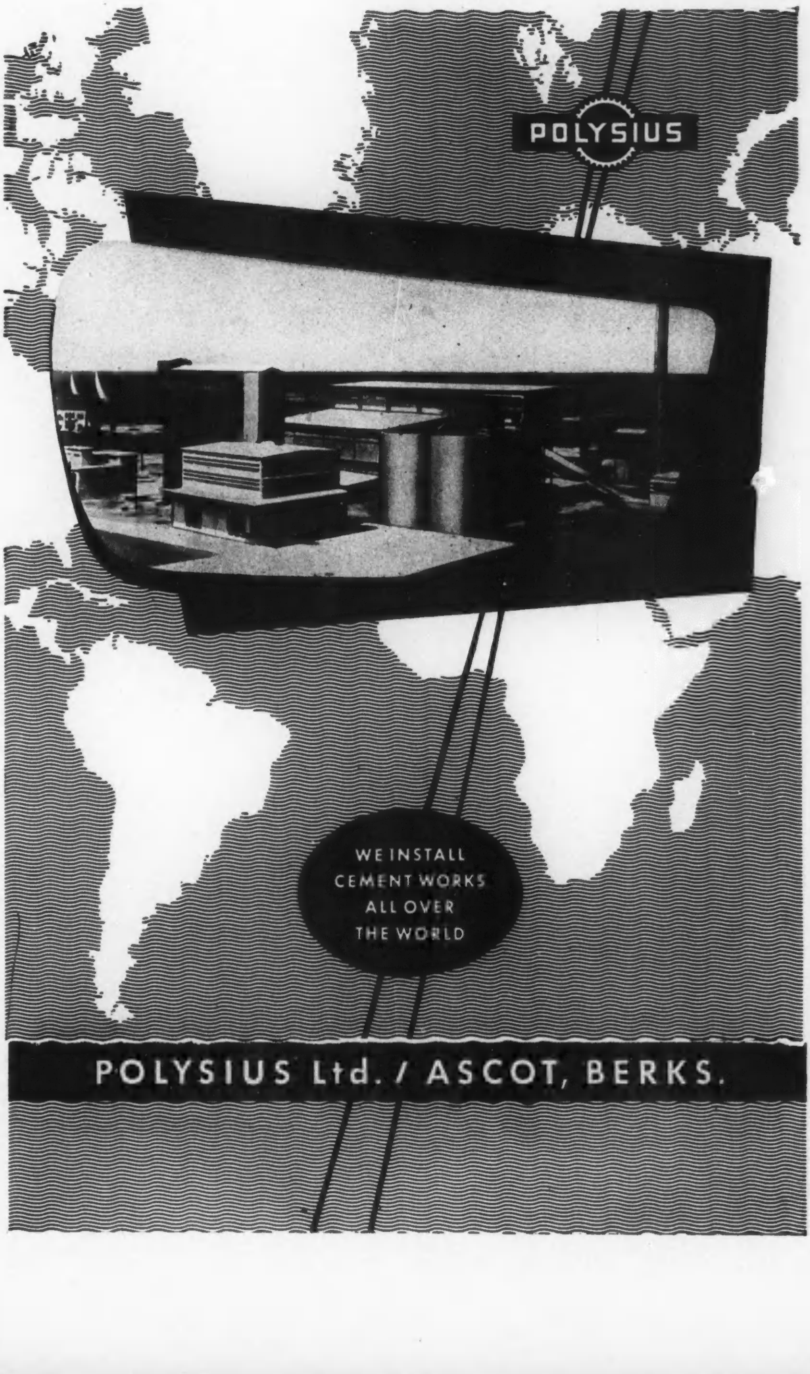
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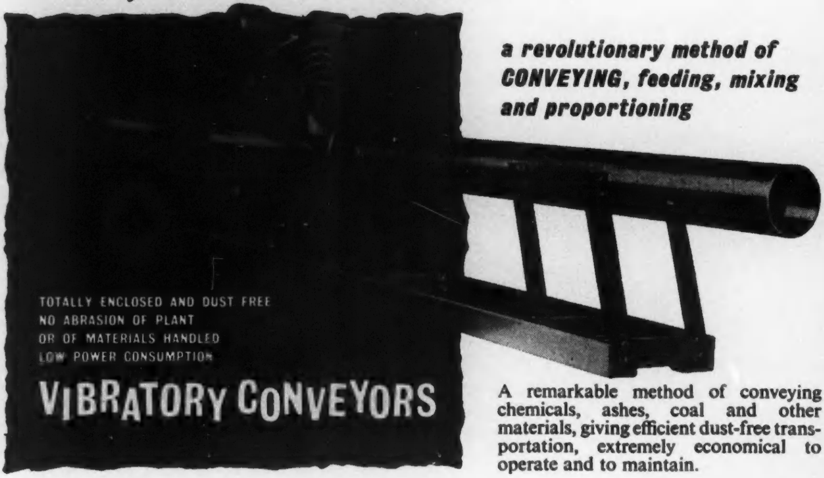

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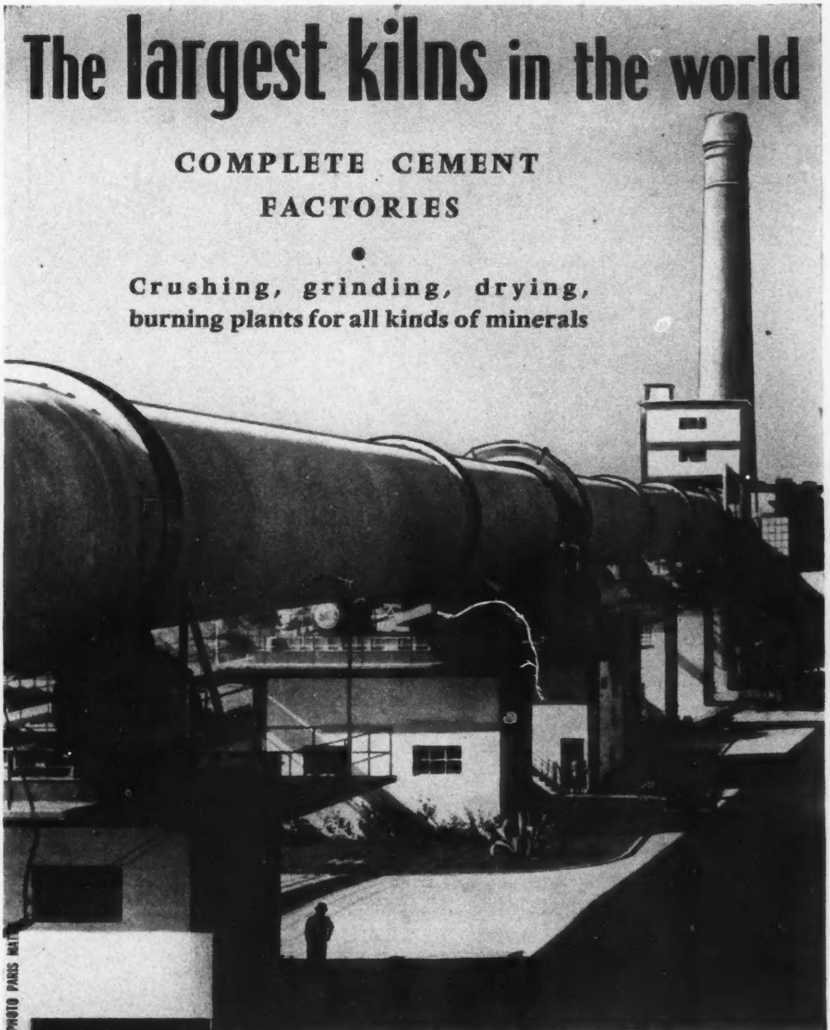

Alhandra cement factory (Portugal). View of the kiln (167.5 m x 4.8/5.3 m - 1600 T/day)

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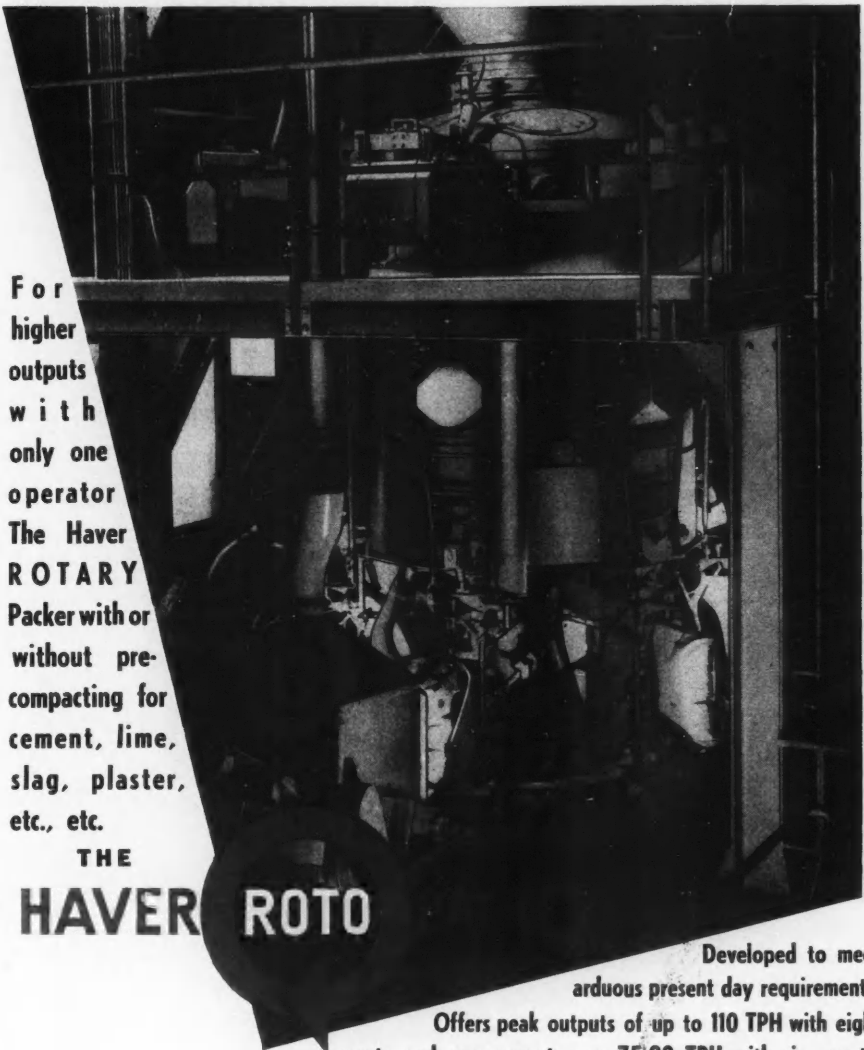

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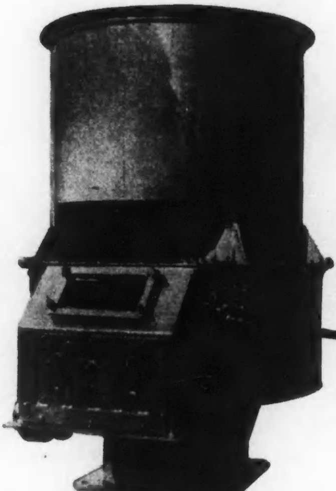

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Simplified Phase Diagrams For Cement Pastes.

By F. S. FULTON

CEMENT paste which has been cured continuously under water is a three-component system consisting of unhydrated cement, hydrate and water. The method used by Mr. T. C. Powers[1] to illustrate the transition from the system (cement plus water) to that of the three-component system is shown in the first and second diagrams in *Fig.* 1, in which

w_0 = weight of water in the fresh paste (corrected for bleeding and any dilation of the paste during hydration).

c = weight of original cement.

V_c = specific volume of the original cement (cu. cm. per gramme).

w_c = weight of capillary water at a stage when a fraction m of the cement has hydrated.

N = volume of cement gel produced by the hydration of 1 c.c. of cement.

w_e = weight of evaporable water under specified conditions of drying at hydration stage m.

p_g = inherent porosity of the gel.

All weights are in grammes.

The construction is based on the assumption that once corrections have been

made for bleeding and early dilation, the total volume of the system remains constant for any given paste at all stages of hydration.

As shown in *Fig.* 1, the fresh paste consists only of cement and water. When a fraction m of the cement has hydrated, the system consists of capillary water, unhydrated cement and porous gel, the pores in the gel being filled with water. The gel water and the capillary water together constitute the evaporable water. The third diagram in *Fig.* 1 represents therefore the proportions of evaporable water, gel solids, and unhydrated cement in the particular paste at hydration stage m.

The diagram is over-simplified, and a more satisfactory expression[2] for the volume of the gel solids is $V_{hc}(mc+w_n)$, in which V_{hc} is the specific volume of hydrated cement in cu. cm. per gramme and w_n is the weight of non-evaporable water, under the specified drying conditions, at hydration stage m. However, from a consideration of the values given by Mr. Powers it is evident that, for the purpose of diagrammatic illustration, no great error is involved in stating $V_{hc}(mc + w_n) = (1 - p_g)\, NmcvV_c$.

The disadvantage of any diagram of the type shown in *Fig.* 1 is that it illustrates volume relationships for only one paste at one specific stage of hydration. The effects of changes in the ratio of original water to cement, of increasing maturity and of restricted hydration, can be represented only by a succession of similar diagrams.

A new form of diagram is therefore presented which may lead to a clearer appreciation of the process of hydration. From *Fig.* 1 it is seen that

$$w_o + cV_c = w_c + NmcV_c + (1 - m)cV_c$$

and $w_o + cV_c = w_e + (1 - p_g)\, NmcV_c + (1 - m)cV_c$.

Consequently $w_e = w_o + mcV_c - (1 - p_g)NmcV_c$ .. .. (1)

and $w_c = w_o + mcV_c - NmcV_c$ .. .. (2)

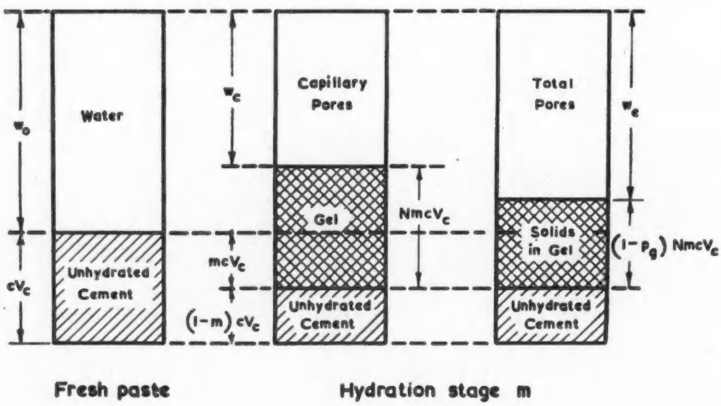


Fig. 1.

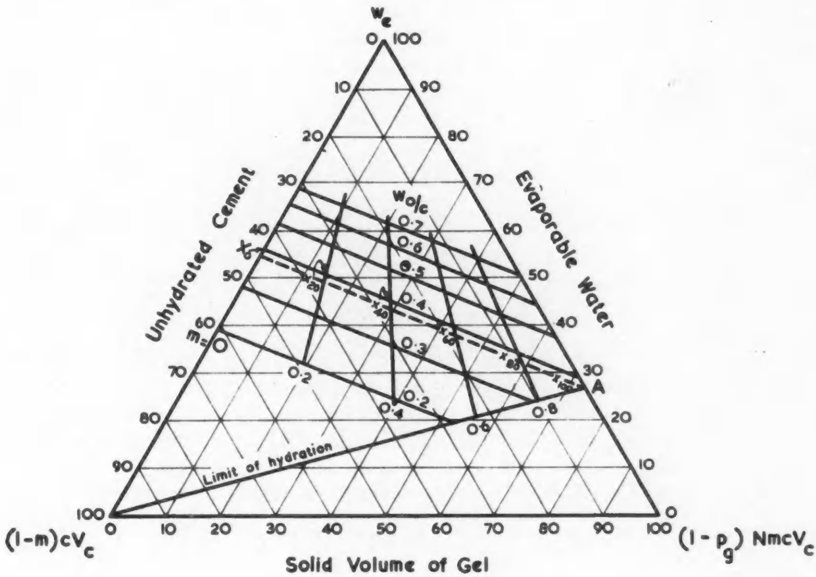


Fig. 2.

The exact values of V_c, p_g and N depend on the methods used in their determination, and also on the cement used. For purposes of illustration the following values, which are given by Mr. Powers[2] may be used.

$N = 2{\cdot}2$ c.c. per c.c.; $p_g = 0{\cdot}28$.

Furthermore, if $V_c = 2$, $\dfrac{1}{\text{specific gravity}} = \dfrac{1}{3{\cdot}15} = 0{\cdot}318$ c.c. per gramme.

Then $\quad w_e = w_o - 0{\cdot}58\, mcV_c \quad \ldots \quad (3)$

and $\quad w_e = w_o - 0{\cdot}38\, mc \quad \ldots \quad (4)$

From these relationships, the phase diagram (*Fig.* 2) may be drawn. For example, for $\dfrac{w_o}{c} = 0{\cdot}40$, let $c = 100$ g.; then $w_o = 40$ g.

By absolute volumes, $cV_c = 100 \times 0{\cdot}318 = 31{\cdot}8$ c.c.

$w_o = 40{\cdot}0$ c.c.

Total $= 71{\cdot}8$ c.c.

Expressed as percentages by volume, $cV_c = 44{\cdot}4$ per cent., and $w_o = 55{\cdot}6$ per cent.

These values establish the starting point X_0 on the hydration curve for a paste

C

of $w_o/c = 0{\cdot}40$. When $m = 0{\cdot}20$, that is when one-fifth of the original cement has become hydrated, the following apply.

Evaporable water $= w_e = 55{\cdot}6 - 0{\cdot}58 \times 0{\cdot}2 \times 44{\cdot}4 = 50{\cdot}4$ per cent.

Unhydrated cement $= (1 - m)cV_c = 0{\cdot}8 \times 44{\cdot}4 = 35{\cdot}5$ per cent.

Consequently the volume of the solids in the gel $= 100 - (50{\cdot}4 + 35{\cdot}5)$ $= 14{\cdot}1$ per cent.

The point X_{20} corresponding to this composition can therefore be plotted on the phase diagram.

Similar calculations establish points X_{40}, X_{60}, X_{80} and X_{100} corresponding respectively to values of m of 0·4, 0·6, 0·8 and 1. The line XXX therefore illustrates the progress of hydration in a paste having a ratio of original water to cement of 0·40.

Hydration lines for other values of w_o/c can be established similarly.

Mr. Powers[1] has pointed out that with water-cement ratios below about 0·38 by weight (represented by the broken line through point A on the diagram) complete hydration of the cement is not possible because there exists insufficient space filled with water to accommodate all the products which would result from complete hydration. Below this water-cement ratio, there will always exist some proportion of unhydrated cement, while at higher ratios there will always be capillary pores. The stage at which all the space filled originally with water is completely filled by the porous gel may be estimated from equation (4), by substituting $w_e = 0$, that is $w_o - 0{\cdot}38mc = 0$. Hence $m = \dfrac{w_o}{0{\cdot}38c}$. For example, for $w_o/c = 0{\cdot}30$, $m = \dfrac{0{\cdot}30}{0{\cdot}38} = 0.79$.

By calculating m for other values of w_o/c the line OA, which defines the limit of hydration, may be drawn.

The completed diagram can therefore be used to illustrate not only the progress of hydration of cement pastes of all possible water-cement ratios, but also to depict the restriction of hydration in pastes of low ratios.

REFERENCES

1.—*T. C. Powers.* "The Physical Structure and Engineering Properties of Concrete." Portland Cement Association Research and Development Laboratories Bulletin 90, July 1958.

2.—*T. C. Powers.* "Physical Properties of Cement Paste." Fourth International Symposium on the Chemistry of Cement (1960).

Accidents in the Cement Industry.

IN the six months ending June 30, there were only thirty-two disabling injuries resulting in loss of time in the twenty-seven cement-producing units of the Blue Circle Group. This number is fifteen fewer than in the same period of 1960. The cumulative frequency rate is now 0·35 compared with 0·53 last year. In the period under review, there were no accidents resulting in loss of time in twelve works.

New Grinding Plant at an American Cement Works.

The works of the Huron Portland Cement Co., at Alpena, Michigan, U.S.A., is claimed to be the largest single cement works in the world. It has a capacity of 2,000,000 tons per year. The mills operate eight months in the year, and the kilns operate all the year round. The kilns have a capacity, at present, of 5000 tons per day. Finished cement can be produced at the rate of about 8600 tons per day. The apparent gap is filled by reserves of clinker of up to about 400,000 tons in a storage area where clinker is stored during the winter months while the Company's cement-carrying ships are ice-bound. The storage capacity of finished cement is 175,000 tons. (It is reported that a new 15-ft. rotary kiln 460-ft. long is to be installed; it is expected to be in operation early in 1962, and will increase the capacity of the works by 330,000 tons per year.)

The most recent of several major innovations, since the Company became a subsidiary of the National Gypsum Co., is the installation of a new finishing plant which has a rated capacity of 54 tons per hour and is described in the following.

Fig. 1.

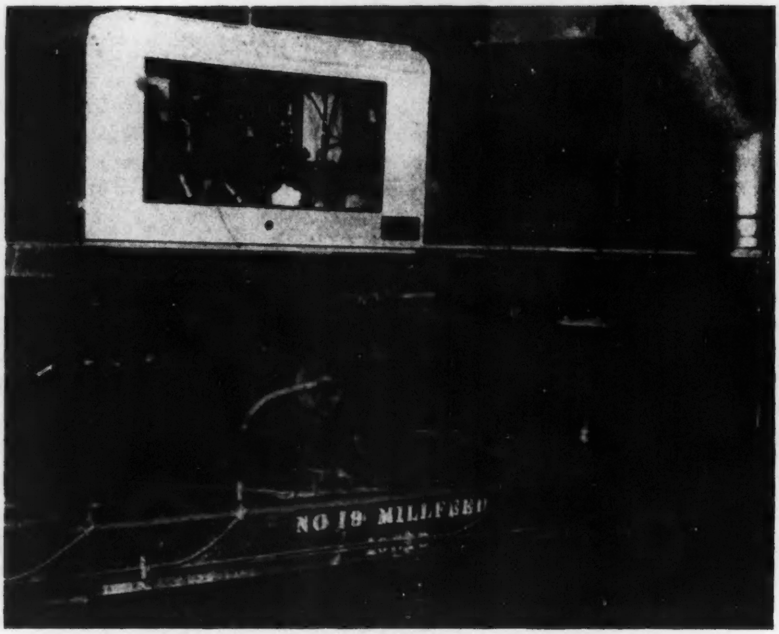


Fig. 2.

Grinding Plant.

Limestone is obtained from quarries located a few hundred yards from the cement works. Shale is delivered by rail. The feed to the mills is controlled by an electronically-operated system (*Figs.* 1 and 2). The raw-material grinding mills comprise nine 7-ft. by 26-ft. tube-mills with 14-ft. air-separators and four 10-ft. 6-in. by 15-ft. mills with 16-ft. air-separators. The raw material is reduced to a size such that 90 per cent. passes a 200-mesh screen. Sixteen mills deal with the "Bradley" product and three grind the clinker. Final classification is carried out in nineteen separators, ranging from 14-ft. to 18-ft. in diameter. The newest and largest mill, which commenced operating in the autumn of 1960, uses 215 tons of grinding balls in a 2750-h.p. 12-ft. by 36-ft. "Compeb" tube-mill (*Fig.* 3), which is designed to have an output of 54 tons per hour. It is connected to an 18-ft. air-separator driven by a 250-h.p. motor and supplied by the Sturtevant Mill Co., of Boston, Mass.; the output of the separator is guaranteed although there has been no previous experience of such high output with an 18-ft. separator.

It is estimated that the new mill, which is said to be at present one of the largest in the world, produces about 58 tons per hour, and this is considered to be the normal operating capacity. One run of 24 hours produced an average of

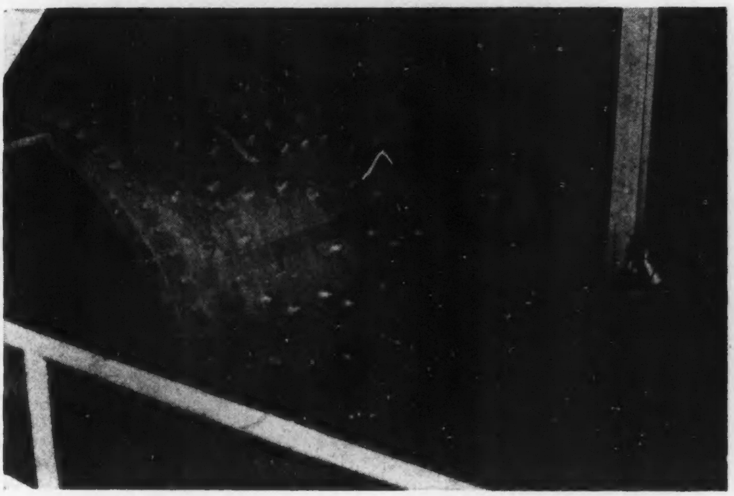


Fig. 3.

nearly 70 tons per hour. The two-compartment mill receives 66 to 70 tons per hour of material having a maximum size of 2-in. The first compartment is loaded with balls to the extent of 36 per cent. of the internal volume. Of these grinding media, 1·4 per cent. are 4-in. in diameter, 7 per cent. 3½-in., 43·3 per cent. 3-in., and 31·2 per cent. 2½-in. The remainder are smaller. In the second compartment, 34·6 per cent. of the grinding media are 1¼-in. in diameter, 37 per cent. 1-in., and the remainder are smaller. About 35 per cent. of the internal volume of the second compartment is occupied by grinding media.

Air Separation.

About 75 per cent. of the ground material is finer than 200-mesh, less than 5 per cent. exceeds 100-mesh, 7·7 per cent. is between 100-mesh and 150-mesh, and 12·5 per cent. is between 150-mesh and 200-mesh. The product is passed to the air-separator, which consumes about 225 h.p. to drive the pinion shaft at 500 r.p.m., and receives the material and passes it through selector blades. The blades, which are 2ft. to 2ft. 6in. long and taper from 10½in. to 12in., are mounted so as to whirl the material in a horizontal spray. The overhead fan, which has twelve 3-ft. 6-in. blades, sucks up the fines, separating centrifugally any large particles which might otherwise escape with the fines. Simple adjustments allow exact regulation and control of the centrifugal force and the air currents. The fines are expelled through a conical outlet and the oversized material passes through another outlet for re-introduction into the grinding system.

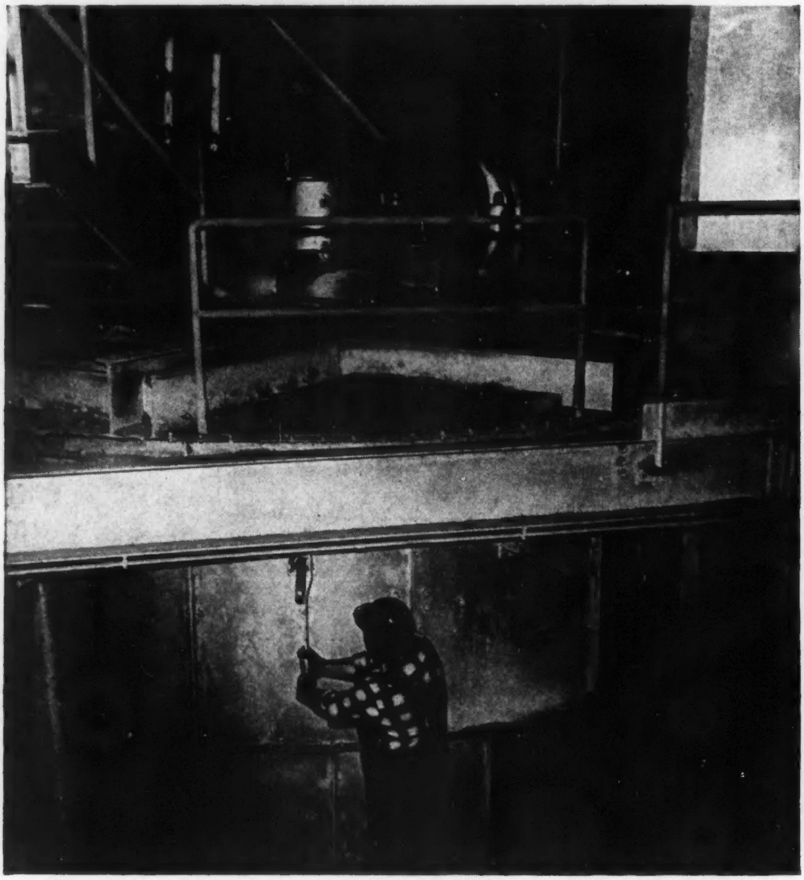


Fig. 4.

Several methods can be used to regulate the size of particles recovered from the separator. The speed of the vertical shaft can be varied whereby the suction of the top fan is affected. The volume of air sucked upwards by the top fan can be controlled by opening or closing a series of diaphragm valves which are spaced around the periphery of the separator (*Fig.* 4). The number of blades on the upper plate can be varied; the fewer the number of blades the coarser the particles withdrawn, since a larger number of blades creates more interference to the inward passage of the cement-laden air and only the finest particles can get through.

The fines leave the separator at a temperature of from 160 deg. to 200 deg. F., having undergone an increase of temperature through attritional heat, accompanied by cooling of the ambient air during the classification process. The usual range of cooling temperatures is 15 deg. to 60 deg. F.; investigations are being made to effect further cooling during hot weather. The fines thus separated are such that 88 per cent. pass a 325-mesh, and have a specific surface of 1650 sq. cm. per gramme measured on the Wagner apparatus.

Determining the Initial Set.

Fig. 1.

Fig. 2.

The apparatus in *Fig.* 1 is a penetrometer for the determination of the initial set of concrete, mortar, or cement on sites or in laboratories. The apparatus, which has been developed by Soiltest, Inc., is 7 in. long and is intended to be used in conjunction with A.S.T.M. Test C-403. The procedure is to force the steel shaft, which has an area of 0·05sq. in., into the material (*Fig.* 2) to a depth of 1 in. as marked on the shaft. The resistance in pounds per square inch is shown on a direct reading scale by the sliding sleeve which is held automatically in position until released. The scale ranges from zero to 700 lb. per square inch. It has been established that initial set of concrete is reached when the resistance is 500 lb. per square inch.

A High-speed Grinding Process.

WHAT is claimed to be an improved high-speed grinding process using a vibrating ball mill has been devised by Dr. H. E. Rose and Dr. R. M. E. Sullivan of King's College, London. The process, which is available under licence from the National Research Development Corporation, utilises grinding rates more than fifty times greater than those attainable in present commercial mills. The increased rate of grinding can be obtained by a moderate increase in the speed of rotation of the out-of-balance weight shaft of the mill. To do this by merely increasing the speed of driving of a conventional mill would introduce mechanical problems. Therefore the effective exploitation of the possible increase in the speed of operation of a mill requires basic changes in the design of the machine. Theoretical considerations suggest that to achieve a high rate of grinding, operation

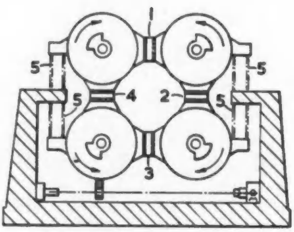


Fig. 1.

of vibration mills at high frequency is essential. In a large mill the loads on the bearings and frictional losses become very great but this obstacle may be overcome by introducing operation by resonance. The bearing load is zero and frictional losses are very small at exact resonant speeds. Such operation requires stiff or strong springs, which are the probable limitation of what can be achieved by this method. Overall efficiencies of between 65 and 75 per cent. are claimed. The largest possible fraction of the energy absorbed by the mill charge should be converted to energy associated with new surface. Theory indicates that use of grinding media of the greatest density are required. It is also considered that there is an optimum mill filling ratio. The type of motion imparted to the mill is also important and a circular motion has been found to give a rate of grinding twenty times greater than the same amplitude of motion entirely in a horizontal plane.

The vibrating ball mill shown diagramatically in *Fig.* 1 comprises four mills arranged to vibrate in anti-phase. By this means, the disturbing force acting on the frame is minimised. Parts 1, 2, 3 and 4 are the primary or stiff suspension; parts 5 are the secondary or soft suspension.

An Investigation of the Slaking of Quicklime by Steam.

IN a recent number of "Zement-Kalk-Gips," M. KREUTZ and G. SCHIMMEL describe an investigation of the behaviour of quicklime when it is slaked by superheated steam at atmospheric pressure and also by high-pressure steam.

Apparatus.

The apparatus (*Fig.* 1) used for slaking the quicklime in superheated steam comprise two copper tubes, one of which was half the diameter of the other, connected by a tapered section (*Fig.* 2). The smaller tube was packed with Raschig rings and the larger tube accommodated a porcelain boat containing the charge of quicklime. Helical heating coils were wound around both tubes and the assembly was enveloped in a galvanised metal jacket filled with vermiculite. Small side-tubes, connected at right-angles to the larger tube, allowed thermometers to be inserted to record the temperature of the steam, before contact with the charge, and the temperature of the lime during the slaking process. The steam became superheated as it passed through the heated Raschig rings in the smaller tube, and it then entered the larger tube containing the lime.

Tests.

The raw material used in the investigation was a natural finely crystalline limestone crushed to pieces of 4 cm. to 6 cm. and burned at different temperatures between 900 and 1300 deg. C. for different periods of time. The quicklime was then crushed further and the fraction between 2 mm. and 5 mm. was selected for the slaking tests. Every test was carried out at a definite temperature to which the apparatus was heated before admission of the steam, and heating was maintained for half an hour after the supply of steam had been discontinued. Tests were performed at different temperatures for different periods.

Each sample was subsequently tested to determine the percentage of the lime

Fig. 1.

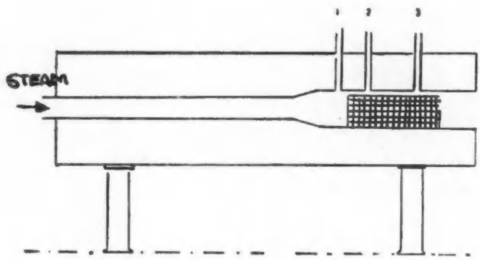


Fig. 2.

which had crumbled during slaking, and the molecular ratio CaO H_2O was found by chemical analysis. Values of the plasticity were obtained by means of Emley's apparatus.

After each experiment, there remained an appreciable percentage of grains which had not fallen apart into a powdery hydrate. These hard grains, however, had not escaped hydration since they mostly contained water in amounts approaching the theoretical proportion for calcium hydroxide. The proportion of non-disintegrated grains of hydrate from lime burned at 1300 deg. C. was always below 50 per cent., while with lower burning temperatures the reverse occurred.

The proportion of water in the hydrates deviated most from the theoretical value where the minimum temperature of slaking had been high, suggesting that above 100 deg. C., the reverse reaction may begin to come into effect. After a certain value had been reached, prolongation of the period of slaking did not increase the proportion of combined water. The rate of slaking was lower for the limes burnt at 1300 deg. C. than for those burnt at lower temperatures. Few samples showed complete hydration.

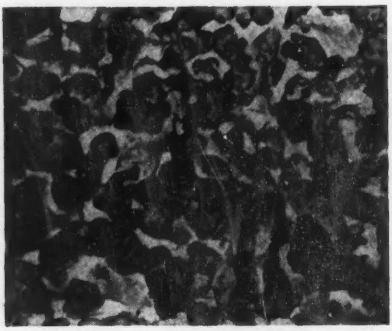


Fig. 3.—Electron-micrograph of the Fractured Surface of a Grain of CaO.

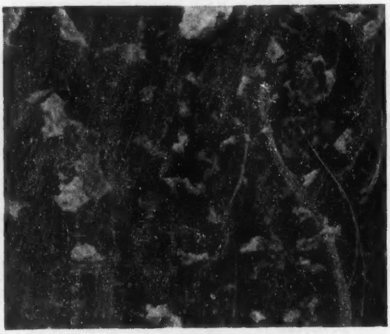


Fig. 4.—Electron-micrograph of a Grain of Ground $Ca(OH)_2$.

The Emley values tended to be rather low, for example between 113 and 180, for the self-powdered hydrate. The hard grains had to be ground in a ball-mill before the tests could be made, and the values were higher.

Slaking without Expansion.

In order to investigate the phenomenon that quicklime can apparently be slaked without expansion of volume and the consequent falling apart, 1-cm. cubes of limestone were cut with a diamond saw, and burned for six hours at 1000 deg. C. in an electric oven and immediately slaked in superheated steam at about 200 deg. C. Some cubes fell apart but others retained their original form and none of the edges of these exceeded their initial length. Since the oxide and hydroxide have different forms of lattice with different lattice constants (the distance between calcium ions is greater in the case of the hydroxide), it appears that expansion in volume must be accommodated by pores. This would explain the result that grains from lime burnt at a higher temperature fell apart more on slaking than in the case of limes burnt at a lower temperature.

Slaking in Autoclaves.

Further experiments were carried out on slaking lime under pressure in an autoclave. The lime used was burnt at 1050 deg. C. in a gas oven. About 3 lb. of the lime was put in an autoclave fitted with temperature control and a mechanical stirrer. When a steady temperature of 150 deg. C. had been reached, water was injected while stirring the charge over periods of 1, 40 and 60 minutes. After the addition of water was complete, the heating of the autoclave was switched off. When the temperature had fallen to 130 to 135 deg. C., the water vapour was allowed to blow out and the autoclave was cooled with water. It was opened at room temperature and the slaked lime removed.

Again there was a proportion of hard grains which were shown by chemical analysis to consist mainly of hydrate, and the general properties of the material were similar to those of the product from hydration by superheated steam at atmospheric pressure.

Visual Results.

The two photographs taken with an electron microscope (at a magnification of 5000) show carbon impressions of the fractured surface of a grain of calcium oxide (*Fig.* 3) and a grain of hydrated lime (*Fig.* 4) ground in a mortar.

Experiments were carried out in which the process of slaking by superheated steam could be recorded by X-ray diagrams. These showed that calcium oxide free from hydroxide was converted at 140 deg. C. to calcium hydroxide containing some oxide, but that when the apparatus was allowed to cool and the steam no longer superheated, the recordings of the oxide disappeared. The recordings of the hydrate were then more intense than before, suggesting a state of finer subdivision.

Prevention of Dermatitis in the Cement Industry.

MATTERS relating to the cause, prevention and incidence of dermatitis in the cement and concrete industries were brought to notice in a law case, early this year, in which a firm supplying ready-mixed concrete was sued by an ex-employee who alleged that he contracted this cutaneous disease in the course of his employment. The employee's hands were soiled with oil, grease and dust as well as cement, and the basis of his case was that the firm did not supply a barrier cream. The result of the case turned on the question whether barrier creams were efficacious in preventing the disease. In the event, the defendants won the case because evidence did not establish this to be so. The judge, in his summing up, quoted medical evidence to the effect that barrier creams were not necessarily a preventative against this particular disease. It was stated that the principle or theory of the action of barrier creams is good, that is, the cream is supposed to provide a layer on the skin which prevents noxious substances reaching the skin. Also, the only proof of the value of a barrier cream must come from properly conducted trials carried out under industrial conditions and followed by an assessment of the incidence of dermatitis.

Views of the Cement Industry

From the evidence available it appears that dermatitis is much more prevalent among workmen handling wet concrete, especially if oil is present, than among workmen in cement works. Enquiries made at a large firm of cement manufacturers elicited the information that this particular firm does not issue any special instructions to employees on the precautions to be taken when working with cement, because it is the belief that dermatitis can be prevented by personal hygiene. Throughout the works and supply depots of the firm, adequate washing facilities are provided with plentiful supplies of hot water and means of drying. Barrier creams are available for the employees' use. The employees make considerable use of these facilities, and, as a consequence, only six cases of dermatitis were recorded among the thousands of employees in twenty-eight works and numerous depots.

It is thought that the daily use of barrier creams, although not necessarily providing complete protection against dermatitis, certainly conditions the hands for easier and quicker removal of cement by washing and thereby no doubt helps to lessen the chances of dermatitis developing.

It seems to be fairly well established that oil dermatitis is more common than cement dermatitis, and that the latter form is an allergy and is not contagious. That some workers are allergic to dermatitis is considered to be such a basic factor in the incidence of the disease that it is reported that one firm of precast concrete products makers required each new employee to certify that he had never suffered from dermatitis. (Some views of the precast concrete industry are given in " Concrete Building and Concrete Products," May 1961).

Medical Views

A summary of the present state of medical knowledge of the disease as ex-

perienced in the cement industry is given by Dr. Charles D. Calnan in an article entitled "Cement Dermatitis" in the "Journal of Occupational Medicine," January, 1960, from which the following information and data are abstracted.

There is evidence of the disease throughout many centuries, but more recent medical opinions are that excessive sweating and over-dryness of the skin are predisposing factors. In cement works, the finishers, packers and men sealing sacks were among those most liable to contract the disease. Reports from Russia state that men carrying bags of cement on their backs without adequate protection incurred the disease. During the past decade the incidence of the disease has been allied to chromate sensitivity. It has even been claimed that handling cement with chrome-tanned leather gloves has at least aggravated the disease. Many investigators conclude that allergic eczematous hypersensitivity to chromate is the principal cause of dermatitis, although less extreme opinion states that chromate sensitivity may initiate and maintain cement dermatitis without being entirely the primary cause.

Chrome Compounds in Cement

There are several possible sources of chrome compounds in Portland cement. In the article mentioned, it is stated that in the raw materials, namely chalk, clay (and the resultant slurry), and gypsum there is practically no chromate (expressed as $K_2Cr_2O_7$). Probable sources are coal, balls in grinding mills, and the refractory bricks in kilns. In a kiln, 300 ft. long, a length of about 60 ft. might be lined with special bricks, which may contain 8 to 10 per cent. of hexavalent chromate. In the course of wearing, the chrome in the bricks finds its way into the cement to a maximum extent calculated to be 27 parts per million. From the chromium-steel balls in grinding mills it is estimated that, in the case of one works, the theoretical amount of metallic chromium from this source in 100 g. of cement is 200μg The chromate from these sources accounts for much of the total chromate content of cement which, in British cement, may be up to 1000 micro-grammes per cent. The small remaining part may be due to the chromatic-content of the pulverised coal used as fuel in the kilns; the content of the fuel ash may be about 945μg. per cent. There may, however, be considerable disparity (even up to tenfold) between the total chromium content of the cement and the amount present as hexavalent chromate.

In modern cement works, states Dr. Calnan, dermatitis is infrequent in spite of the fact that cement dust is so fine. Apart from the reduction of the hazard by mechanisation (of packing as well as other processes) and automation, the workmen are exposed to dry rather than wet cement and the absence of moisture avoids slaking of the lime, which appears to be the virulent substance. On the other hand, sufferers from the disease may often be men exposed to cement dust whose clothing becomes impregnated; the majority of patients are sensitive to chromate, and their work is often hot and heavy causing them to sweat profusely. The cement dust settles on the sweating skin and becomes mixed in solution, resulting in generation of heat and an increase in alkalinity consequent upon slaking of the lime.

The Cement Industry in Europe in 1960.

THE European cement industry continues to benefit from general trade expansion, according to "The Cement Industry in Europe—1960" (published by the Organisation for European Economic Co-operation), and production in 1960 increased by 6 per cent. Although lower than in the previous year, this expansion was due entirely to home demands, since exports showed a downward tendency. Cement prices at the end of 1960 were much the same as those at the end of 1959.

The world production of cement in 1960 was 315,000,000 tons of which 97,000,000 tons was produced by countries which are members of O.E.E.C. Of these countries Germany produced the greatest amount, namely 25,056,000 tons, followed by Italy with 15,817,000 tons, France 14,173,000 tons and the United Kingdom 13,500,000 tons. (All quantities in the foregoing and following are in metric tons.)

The productive capacity of the cement industry in member countries at the end of 1960 amounted to 109,700,000 tons which is about 7,200,000 tons more than at the end of the previous year. The greatest increase was obtained by the installation of new kilns at existing works, and improvements in plant other than kilns. This increase is computed after allowing for some kilns taken out of operation. Germany had the greatest increase in capacity due to the establishment of a new works and adding six kilns to existing works, representing an increase in capacity of 1,400,000 tons. Of the five new works installed by member countries, two are dry-process works and three are wet-process works.

After a continuous decline since 1955 exports in 1959 showed an improvement, but in 1960 exports dropped by 6 per cent.; this tendency was general for most member countries. Belgo-Luxembourg Economic Union (B.L.E.U.), which is classified as a single country, exported 1,096,900 tons, the United Kingdom exported 1,072,200 tons and France 998,300 tons.

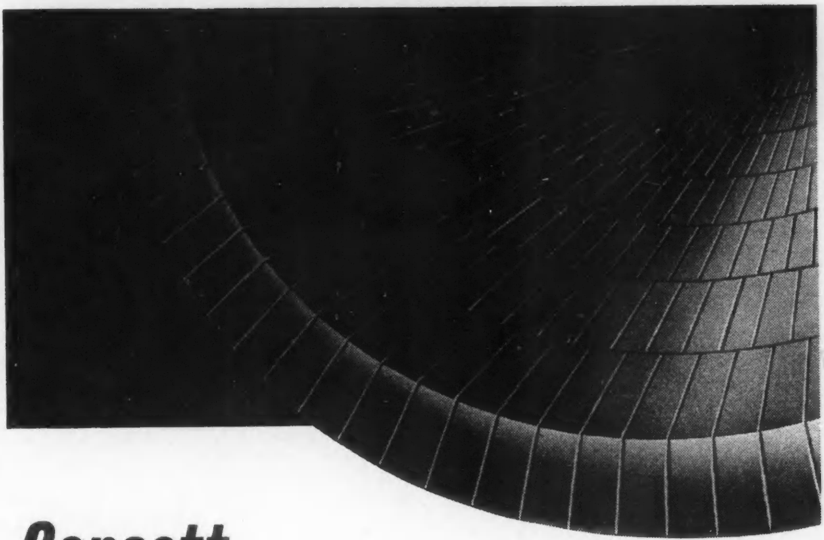
The total imports of cement by member countries, most of which represent trade between the member countries, amounted to 1,917,000 tons, which is 64,000 tons more than in 1959. The United Kingdom imported 118,700 tons in 1960 compared with 35,300 tons in 1959. The Netherlands remain the largest importers of cement with 1,393,200 tons for 1960.

The total consumption of cement by member countries in 1960 was 93,300,000 tons, an increase of 6,000,000 tons compared with the previous year.

The trade in clinker between member countries amounted to 775,000 tons and exports to non-member countries were about 280,000 tons.

During the year the average labour force employed in the European cement industry was about 109,600 compared with 109,400 in 1959. There were fewer manual workers, but the clerical and executive staffs increased. This trend, which has been apparent for some years, indicates the increase in mechanisation. In the United Kingdom the total number of persons employed in the cement industry in 1960 was 17,100.

Member countries as a whole expect to increase their cement productive capacity by 14,000,000 tons during the year 1961-1962 and by the end of 1962



to 123,000,000 tons. Of these estimated additional capacities Germany will have 4,000,000 tons, which will be accomplished by existing kilns, as no new works or kilns are intended to be set up during this forthcoming period. Italy's productive capacity is expected to be increased by 3,100,000 tons by the installation of twenty-four kilns. Ten new kilns, all of which will be rotary kilns, are expected to be installed in the United Kingdom, three in new works and seven in existing works.

Associated Portland Cement Manufacturers Ltd.

In the Annual Report for 1960 of the Associated Portland Cement Manufacturers Ltd., the Chairman, Mr. J. A. E. Reiss, B.E.M., announced that deliveries of cement in Great Britain were 5·2 per cent. higher than in 1959. The programme of converting four of the works to oil firing was completed and resulted in economies of fuel, but the reduction of price of cement, in February 1960, and the increased costs of wages and coal and the imposition of a duty on oil cancelled these savings. The increase in costs resulted subsequently in prices being raised.

Export trade showed a further moderate reduction but sales of special cements increased. Deliveries in the early months of 1961 showed a greater increase than ever experienced (9·8 per cent.). The output of the building industry has shown a marked rise which, coupled with the increasing use of concrete building materials, points to the need for more rapid expansion of capacity than was intended twelve months ago. Last year a three-year plan to add nearly 1,000,000 tons per annum to the production capacity was announced and the first fruits of this programme are already coming to hand in that the second kiln at the Cauldon works went into full production in January last and a new kiln at Plymstock works is expected to be in operation by the middle of this year.* The building of a 400,000-ton works near Dunbar is to commence soon and building work has already begun on a site at Westbury. A decision has been made in principle to increase this programme to the extent of about 500,000 tons per annum, part of which will be by increasing the capacity of existing works, since expansion can be effected more quickly in this way than by starting on a new site.

The works overseas sold 2,489,500 tons of cement thereby exceeding previous records. The Commonwealth Portland Cement Co., Ltd. (Australia), acquired the Metropolitan Portland Cement Ltd. An extensive limestone deposit near Geelong in Victoria was acquired, and a new company, The Victoria Portland Cement Co., Pty., Ltd., has been formed with the object of erecting a new works to produce 300,000 tons per annum. Malayan Cement Ltd., again achieved record results and plans for further expansion of capacity are in hand. The Mixcoac Co., and Tolteca Co., in Mexico, experienced a satisfactory year's working, the new works at Atotonilco having commenced production recently. The Golden Bay Cement Co., Ltd., New Zealand, surpassed previous record results and has acquired a primary interest in the Waitomo Portland Cement Co., Ltd., which operates a 60,000-ton plant at Te Kuiti in the North Island.

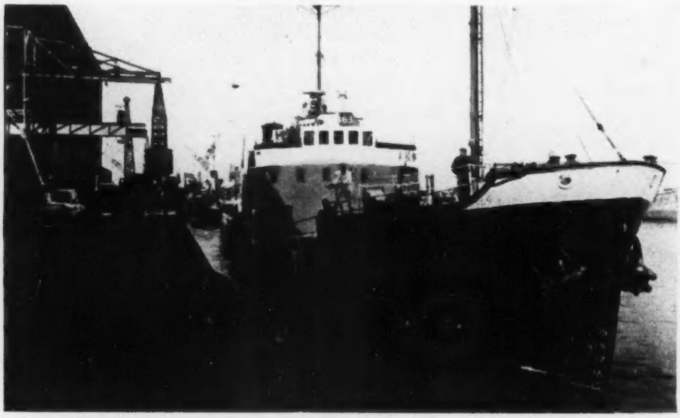
* This kiln is now in operation.

Plans are being put into operation to modernise and expand production at Te Kuiti.

In South Africa, the creation of the Republic and withdrawal from the Commonwealth have affected trade generally and, while on balance the results of Whites South African Portland Cement Co., Ltd., showed little change last year, the course of trade this year is viewed with some uncertainty. The Salisbury Portland Cement Co., made record deliveries but, since there has been a marked reduction in constructional work, trade will inevitably be less. In Kenya, the East African Portland Cement Co., Ltd., had a successful year's trading, but political developments have had an adverse effect. The new works in Nigeria, which has a capacity of 200,000 tons a year, came into production in 1960.

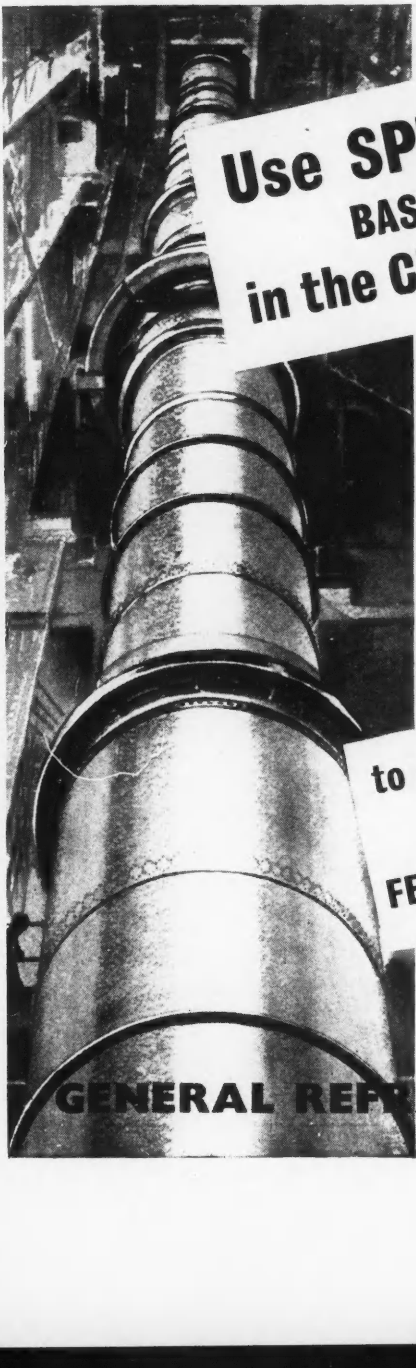
In Canada, productive capacity in British Columbia is in excess of the present demand and there appears little prospect of early improvement. By taking steps to increase efficiency and to reduce costs, the Ocean Cement & Supplies Ltd., is well placed to take advantage of improved trading conditions.

New Cement Depot.



THE Cement Marketing Co., Ltd., opened recently a new depot at Sunderland to meet the increasing demand in north-eastern England. The depot has been designed to deal with 75,000 tons of cement a year, mainly in bulk. Cement will be delivered to the depot by the Company's cement-carrying ship "Walcrete," which has been fitted with equipment so that the discharge of the cement can be carried out under dust-free conditions. The vessel, which has a capacity of 1340 tons of cement, is loaded at a works in Kent at a rate of 300 tons per hour.

Cement is conveyed from the ship into the depot by a scraper-conveyor at the rate of 200 tons an hour and is discharged into an elevator which feeds two 50-ton hoppers, one for ordinary and one for rapid-hardening Portland cement. A permeable conveyor delivers surplus material to a warehouse in which can be stored 1800 tons of ordinary and 1200 tons of rapid-hardening Portland cement. The cement is returned to the hoppers at the rate of 100 tons per hour through a screw-conveyor.



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